J. Dairy Sci. 91:3010–3014
doi:10.3168/jds.2007-0968

Analgesics Improve the Gait of Lame Dairy Cattle

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ABSTRACT

Pain associated with injuries of the hoof and surrounding tissues is an important cause of lameness. The objective was to detect the attributes of impaired gait that are associated with pain. In 3 separate experiments, lactating Holstein cows (n = 20; n = 21; n = 27) diagnosed with varying degrees of gait impairment were injected i.m. (Exp. 1 and 2) or i.v. (Exp. 3) with the analgesic ketoprofen at 0, 0.3, 1.5, or 3.0 mg/kg of BW. Gait was evaluated subjectively using a numerical rating system (NRS; varying from 1 to 5) and 6 specific gait attributes (back arch, tracking up, joint flexion, asymmetric steps, head bob, and reluctance to bear weight). Each experiment was divided into 3 phases each lasting 3 d: before treatment, after treatment, and during treatment with daily injections of ketoprofen. The NRS improved by 0.25 ± 0.05 with the highest dose of ketoprofen. Although none of the specific gait attributes showed a consistent response to treatment, there was an interaction between dose and experiment for asymmetric steps and reluctance to bear weight; in Exp. 1, but not Exp. 2 and 3, cow steps were more symmetrical (improving by 7.16 ± 1.02), and cows distributed their weight more evenly (improving by 5.84 ± 1.13) at the highest doses of ketoprofen. These results indicated that the NRS was more sensitive than the specific gait attributes in assessing differences in gait associated with pain. The results showed that ketoprofen has only a modest effect on gait, indicating either that this drug has little effect on pain due to lameness or that much variation in NRS was due to factors other than pain.
Key words: dairy cattle, lameness, pain, nonsteroidal antiinflammatory drug

INTRODUCTION

The importance of lameness in dairy cattle and its effect on production and animal welfare is increasingly recognized (Kelton et al., 1998; Rushen, 2001), with studies reporting incidences as high as 55% (Clarkson et al., 1996). Lameness can affect the behavior of cows (Galindo and Broom, 2002; O'Callaghan et al., 2003) and result in reduced milk production (Green et al., 2002), delayed reproduction (Garbarino et al., 2004), and involuntary culling (Gröhn et al., 2003).

Deviations in gait are thought to be due to the pain associated with injuries on the hooves and legs (Whay et al., 1998). Nonetheless, much of the variation in both objective and subjective measures of gait could be attributed to factors other than pain, for instance, ligament or nerve damage (Greenough et al., 1981), and physical constraints such as udder distension (Flower et al., 2006). One method of determining which aspects of gait are specifically associated with pain is to measure changes in the gait of lame cows in response to treatment with an analgesic (Rutherford, 2002).

Studies on horses and broilers used subjective and objective diagnostic approaches to evaluate analgesics (Owens et al., 1995; McGeown et al., 1999) but have not identified gait characteristics associated with pain. Rushen et al. (2007) found that cows afflicted with a hoof injury and treated with an injection of the local anesthetic lidocaine into the hoof bulb showed reduced numerical rating scores (**NRS**), indicating that pain in the hoof could be mitigated using a nerve block. In contrast to the local effects of lidocaine, nonsteroidal antiinflammatory drugs (**NSAID**) provide systemic effects, without causing the sedation and tranquilization associated with opioid-based analgesics. The advantage of this approach is that it could mitigate pain throughout the body, including upper-limb injuries.

The NSAID ketoprofen is effective in controlling pain after surgical procedures in cattle (Ting et al., 2003; Milligan et al., 2004) and is licensed for use in dairy cows in many jurisdictions with no milk withdrawal. The aim of this study was to identify changes in gait due to pain controlled by ketoprofen. A secondary aim was to identify which gait measures were most sensitive to the effect of pain by monitoring changes in a composite gait score and 6 separate attributes associated with impaired gait.

Received December 20, 2007.
Accepted March 31, 2008.
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MATERIALS AND METHODS

Cows and Management

This study comprised 3 separate experiments conducted at University of British Columbia's Dairy Education and Research Centre in Agassiz, British Columbia, in 2004 and 2005. Cows were milked twice daily and fed a TMR formulated to meet the nutrient requirements appropriate for their stage of lactation as recommended by NRC (2001). Water was available ad libitum from self-filling water troughs. All animals were cared for according to a protocol approved by the University of British Columbia Animal Care Committee.

Twenty lactating Holsteins [(mean ± SD) BW: 680 ± 67 kg; parity: 3.5 ± 2.3; DIM: 190 ± 97 d; milk production: 41.2 ± 10.9 kg/d] were used in Exp. 1; 21 lactating Holsteins (BW: 665 ± 53 kg; parity: 3.2 ± 1.2; DIM: 140 ± 57 d; milk production 42.2 ± 12.5 kg/d) were used in Exp. 2; and 27 lactating Holsteins (BW: 691 ± 65 kg; parity: 4.1 ± 1.6; DIM: 139 ± 68 d; milk production: 43.5 ± 11.1 kg/d) were used in Exp. 3. Of the 68 cows used, 6 cows were used more than once (2 cows used in Exp. 1 were used in Exp. 3, and 4 cows used in Exp. 1 were used in Exp. 2).

Treatments

Before the start of each experiment, cows were gait-scored using a NRS from 1 to 5 following Flower and Weary (2006). Each animal was assigned to a dose of ketoprofen (Anafen, Merial Canada Inc., Montreal, Canada), such that treatment groups were balanced according to initial gait score, BW, parity, and DIM. Each study lasted 9 d: a 3-d pretreatment phase (before), 3-d treatment phase (during), and 3-d posttreatment phase (after).

To ensure that the ketoprofen had time to take effect, cows were treated 1 h before gait scoring when using i.m. injections (Exp. 1 and 2) and 15 min before when using i.v. injections in Exp. 3. On treatment days, each animal was held in a headlock and received 30 mL of saline solution combined with the assigned concentration of ketoprofen. For Exp. 1 and 2, dosages of ketoprofen were 0.3, 1.5, and 3.0 mg/kg of BW. For Exp. 3, dosages of ketoprofen were 0, 1.5, and 3.0 mg/kg of BW. Volumes of each dosage were adjusted separately for each cow dependent on BW.

Subjective Gait Assessment

Cows were subjected to all aspects of the experimental procedure, with the exception of NSAID administration, at least 7 d before the data collection period to allow animals to habituate. After milking, cows were administered the ketoprofen treatments and held 15 min to 1 h as described above. Cows were then walked individually down a 40-m long grooved concrete alley and recorded using a video camera placed 10 m from the alley, with the lens axis perpendicular to the walking direction of the cows. At the beginning of each recording session, the alley was cleaned with an automatic scraper.

In each experiment, a different trained observer scored cow gait using the video recordings and a 1 to 5 NRS. For example, gait was scored as 1 (sound) when cows showed smooth and fluid movement, a flat back, steady head carriage, hind hooves fell on or in front of the imprint left by the forehooves (tracking up), joints flexed freely, gait was symmetrical, and all 4 legs appeared to bear weight equally. Gait was scored as 3 (clinically lame) when cows had an arched back, their ability to move freely was compromised, head carriage was steady, hind hooves did not track up, joints showed signs of stiffness, and gait was asymmetrical with a slight limp. Gait was scored as 5 (severely lame) when cows had an extremely arched back, needed vigorous encouragement to move, had an obvious head bob, poor tracking up with short strides, obvious joint stiffness, walked with very hesitant and deliberate strides, gait was asymmetrical, and they were unable to bear weight on one or more limbs (Flower and Weary, 2006).

Observers were experienced in gait scoring and had been trained using the same training tapes. In addition, 6 specific gait attributes (back arch, head bob, tracking up, joint flexion, asymmetric steps, and reluctance to bear weight) were scored using 100-unit continuous visual analog scales (Flower and Weary, 2006). The ends of the visual analog scales had a description of the extreme forms of the condition. For example, degree of back arch was defined as flat at one end (0) of the scale and convex at the other end (100), where convex represented the most extreme back arch the observer had seen in their experience. The observer recorded directly on a computer screen a position on the scale that represented the severity of the attribute. Joint flexion and asymmetric steps were not assessed in Exp. 3, because at the time this experiment took place, new work suggested that these measures could only be assessed with lower intraobserver reliability (Flower and Weary, 2006). All observers were blind to day of experiment and treatment group. Observers scored each video clip twice for each of the gait attributes and twice for the NRS.

Statistical Analysis

Observations on multiple days were averaged to form a mean value per cow per phase per experiment. Values